Space Weather Technical Forecast

Issued on Wednesday 25 September 2024 at 13:30 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

On the 24th of September, the way we distribute this forecast has changed and you will need to take action to continue receiving it. You should have received an email on the 4th of September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk

Space Weather Forecast Headline: G1/Minor Geomagnetic Storm likely, mainly Day 1 (25 Sep). Chance of M-flares (R1-R2 Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Low with a flare peaking at C2.8 at 24/1928 UTC from AR3833 in the northwest quadrant.

There are currently eight sunspot regions on the visible disc with AR3825 having departed beyond the western limb. AR3836 (Dai/Beta-Gamma), in the far southeast, is the largest region on the disc, although its proximity to the eastern limb precludes assigning a confident Zurich classification. AR3833 (Dao/Beta-Gamma), a small region in the northwest, has seen recent proliferation of a number of small spots in both the lead and trailing portions. AR3834 (Cao/Beta), in the southeast, has recently seen the development of some small spots of opposite polarity to the south of the main lead group, leading to its reclassification. AR3835 (Dso/Beta), to the east of AR3834, continues to show some slight growth in its intermediate portion. The remaining regions are mostly small or simple and have remained relatively stable over the past 24 hours.

A CME observed on 22-23 Sep, appears to be directed primarily to the south and east, mostly away from Earth. However, analysis suggests a possible glancing blow on Day 1 (25 Sep), likely from the shock associated with the CME. No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE and DSCOVR at L1, was initially at, or just below, slightly elevated levels 400-420km/s. Wind speeds then from around 24/2100 UTC, reaching Elevated levels of 500-520 km/s 25/0550-0850 UTC. Winds have since eased slightly and are fluctuating between Elevated and Slightly Elevated levels. Density, as measured by DSCOVR, was at or below average until around 24/2100 UTC, increasing to above average and peaking at 17ppcc. Density has recently lowered and is around 10ppcc. The Interplanetary Magnetic Field, Bt, was moderate to weak initially, but has remained at moderate levels since around 24/1830 UTC. The north-south component, Bz, weakly fluctuated until around 24/1830

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

UTC. Since then, Bz has been predominantly moderately negative (southward) fluctuating between +8/-11 nT. Phi angle has remained mostly positive (away from the Sun).

Geomagnetic activity was Quiet to Unsettled (Kp 2-3), increasing Active (Kp 4) from 24/2100 UTC before peaking at G1/Minor Geomagnetic Storm (Kp 5) around 25/0300-0600 UTC.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels. The associated 24-hour fluence was below the Active threshold. The 25/0000 UTC observation was 2.25e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with an ongoing chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: The partial halo CME following the M3.7 flare off the southeast quadrant on 22 Sep may give a glancing blow at Earth on Day 1 (25 Sep) with effects potentially lasting into Day 2 (26 Sep). This may coincide with the ongoing connection to the fast wind from CH72/+. However, this aspect of the forecast is considered to be low confidence. Solar wind speeds are at elevated levels and are expected to decline towards background by Day 3 (27 Sep) when any influence from the HSS or CME arrivals is expected to have waned.

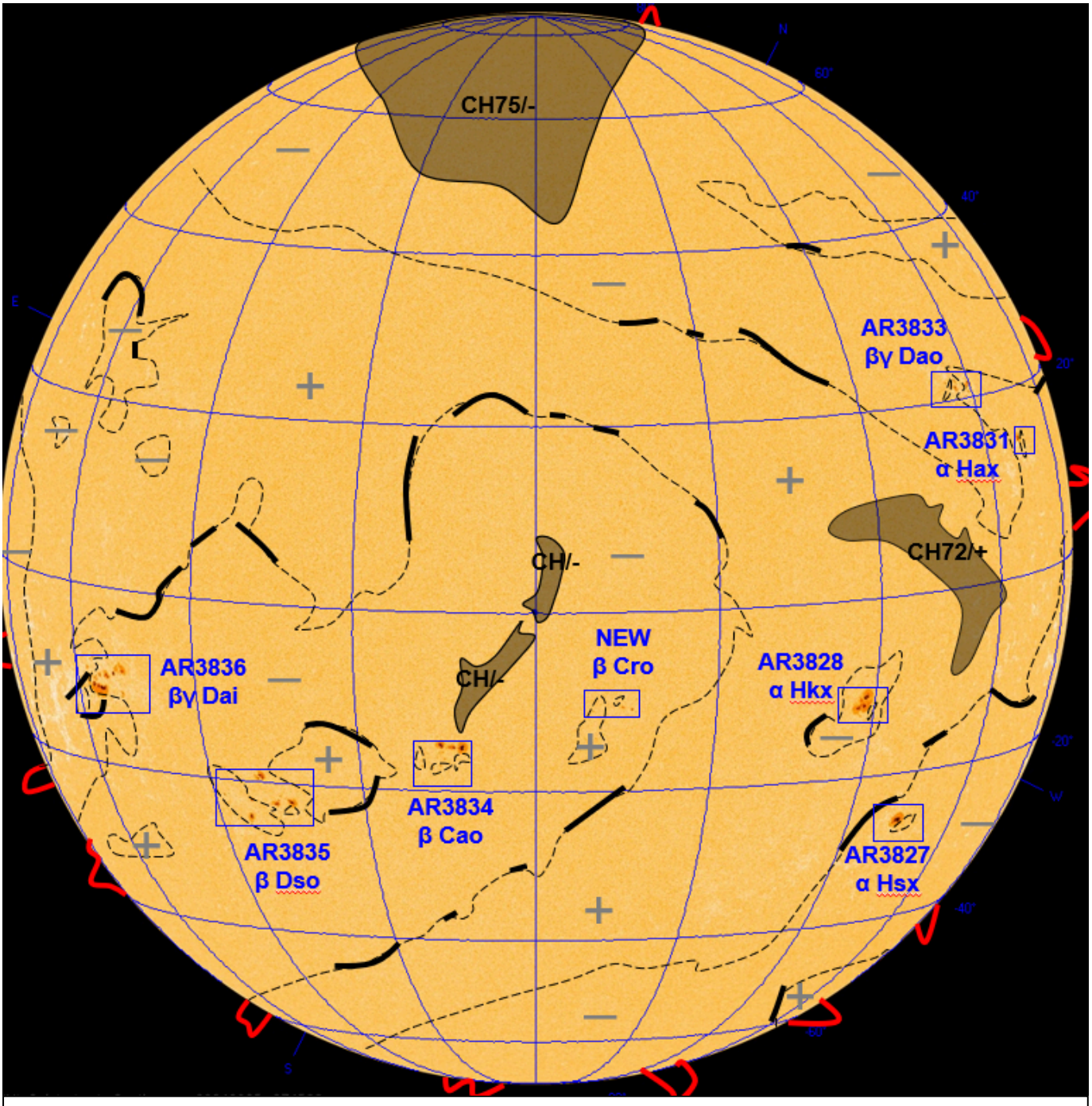
Geomagnetic activity is forecast to be Unsettled to Active (Kp 3-4) with a likelihood of Active to G1/Minor Storm intervals over the next 12 hours given the potential CME arrival. Slight but diminishing chance of G2-G3/Moderate-Strong Storm intervals. Geomagnetic activity is likely to gradually ease to Quiet to Unsettled by the end of Day 2 (26 Sep).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is likely to remain at background levels. High energy electron flux at GOES16 is now at background levels and is expected to remain so. Fluence should remain below the Active (1e8 integrated pfu) threshold.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 1: Solar Analysis Valid 25/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Storms

The partial halo CME which was observed following the M3.7 flare off the southeast quadrant on 22 Sep has been analysed. Results suggest a possible glancing blow on Day 1 (25 Sep) with effects potentially lasting into Day 2 (26 Sep). The bulk of the material appears to be heading below and behind Earth's orbit. However, coronagraph imagery suggests that some shock effects could reach Earth. This may coincide with the ongoing connection to the fast wind from CH72/+ and lead to significant enhancement. However, this aspect of the forecast is considered to be low confidence.

Solar winds are currently fluctuating between elevated and slightly elevated levels 480-510 km/s following connection to the HSS from CH72/+. Wind speeds are likely to remain at this level through Days 1-2 (25-26 Sep) before returning towards background levels during Day 3 (27 Sep). The coronal hole is a persistent feature and is in a generally similar location when compared to previous rotation, but is stronger on SDO/AIA-211 imagery and extends slightly further east-west on this rotation. On the last rotation any impacts were largely swamped by ongoing CME effects. With the positive polarity of the coronal hole and the proximity of the September Equinox, this would suggest the possibility of stronger winds than MOSWOC SWPM would suggest during Days 1-2. MOSWOC Enlil's forecast supports the ongoing enhancement from CH72/+, but is considered to be around 50-100 km/s too slow when compared to reality. Uncertainty lies in the forecast if Earth experiences a glancing blow from the aforementioned CME, as levels could then persist at, or close to, elevated levels until Day 3.

The probability of a G1 during Day 1 (25 Sep) is currently at 100% given the G1/Minor Geomagnetic Storm interval observed 0300-0600, otherwise a probability of 60% is considered for an isolated G1/Minor Geomagnetic Storm interval. Geomagnetic activity is forecast to be Unsettled to Active (Kp 3-4) initially with the likelihood of Active to G1/Minor Storm intervals over the next 12 hours with the potential CME arrival. However, given the favourable geomagnetic environment and proximity to the equinox, if we see more than just shock influence from the CME, then geomagnetic activity could become more significantly enhanced, with a slight chance of reaching a G2-G3/Moderate-Strong Storm interval. This is currently considered to be low confidence. Geomagnetic activity is likely to gradually ease to Quiet to Unsettled by the end of Day 2 (26 Sep).

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	100	20	5	5
Strong	G3	No	20	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

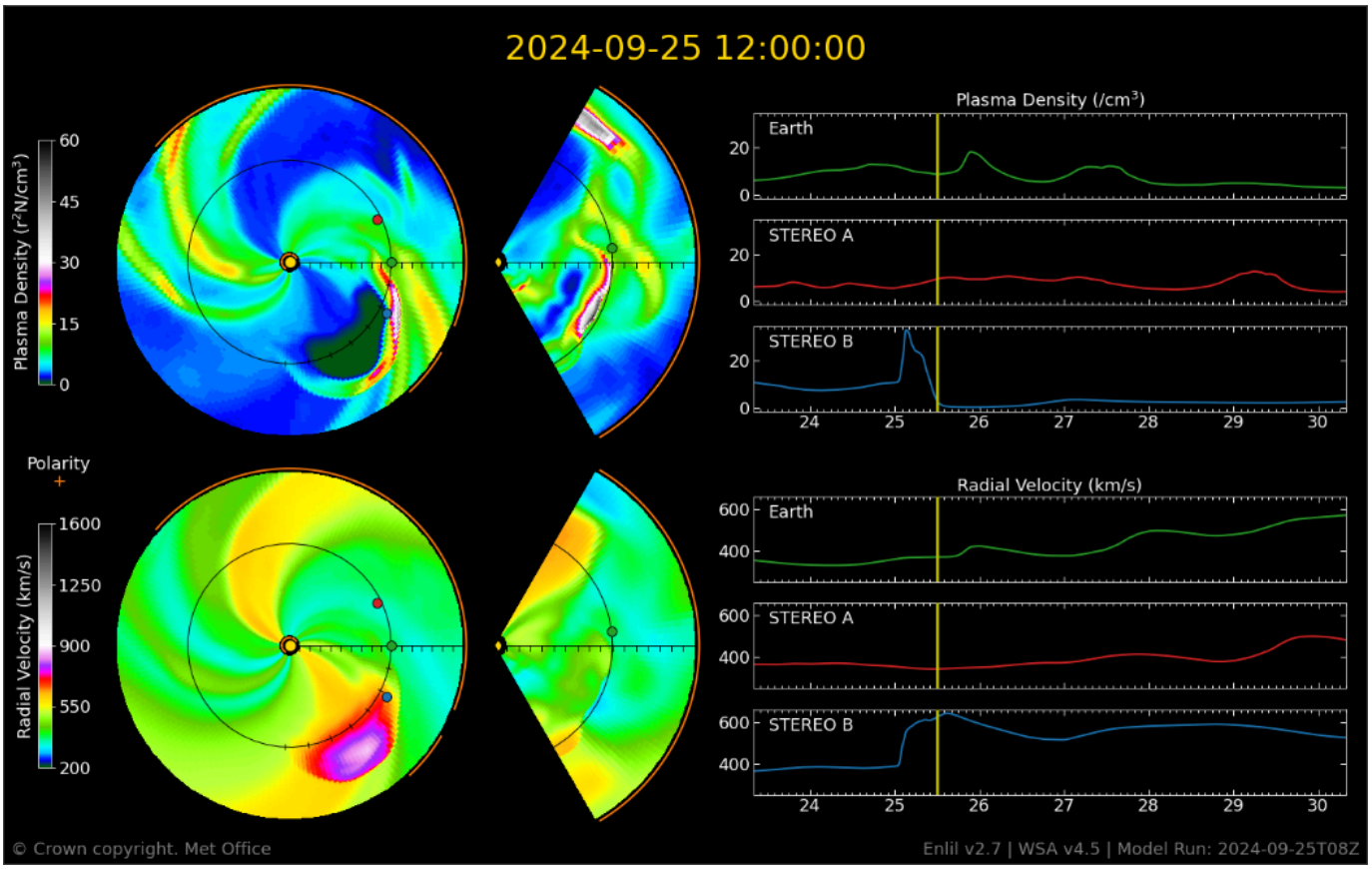
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
2024-09-23 00:31Z	Partial	Filament	SE	1195 km/s	2024-09-25 12:00Z	M3.7 from filament eruption between AR3834 and AR3835. Middle ground of two separate fits

Figure 2: MOSWOC Enlil showing potential for CME arrival during 25 Sep.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 3: MOSWOC Enlil showing number of solutions and spread of arrival times of a glancing blow from the CME during days 1-2 (25-26 Sep)

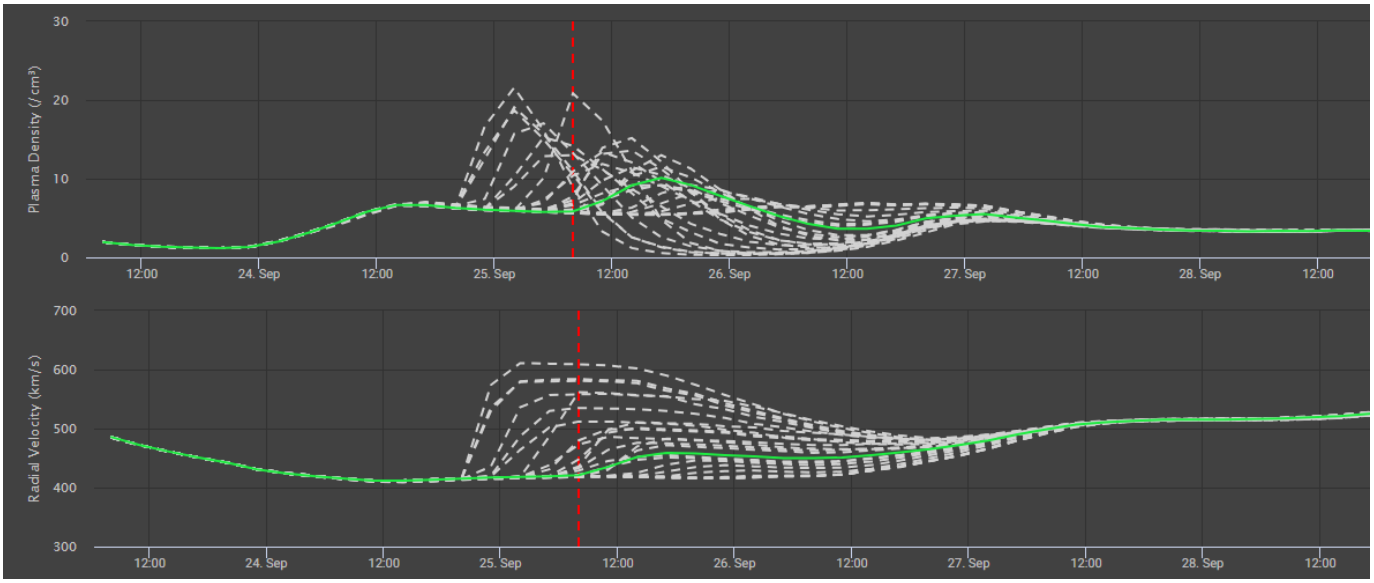
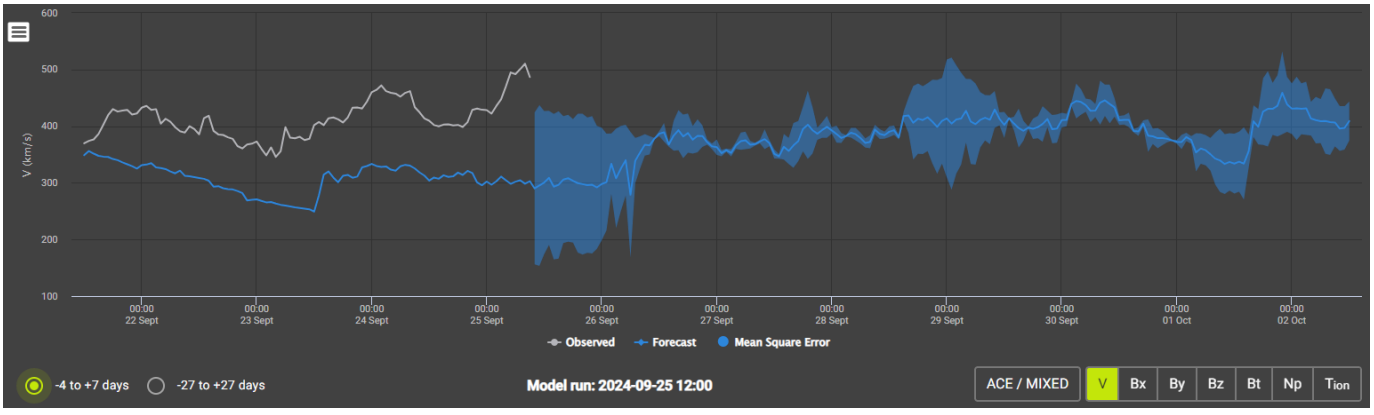


Figure 4: SWPM winds considered to be giving a poor steer.



© Crown Copyright 2024. All Rights Reserved.

Radio Blackouts - X-Ray Flares

Activity is Low with a peak flare of C2.8 at 24/1928 UTC from AR3833 in the northwest. Activity is expected to remain Low to Moderate, with a Chance of isolated M-class flares, most likely emanating from AR3833, AR3835 or AR3836. AR3836, in the southeast, appears to exhibit notable looping in SDO imagery that extends beyond the eastern limb. As such, this region remains one to watch for the possibility of more significant flare activity.

There are currently eight sunspot regions on the visible disc. AR3836, in the far southeast, is the largest region on the disc, although remains difficult to assess due to its viewing angle. AR3828, in the southwest is the second largest region, but is a uni-polar spot with little change of note. AR3383 has seen the proliferation of a number of small spots, but itself remains a small region of limited magnetic complexity. AR3835, in the southwest, continues to show some slight growth in its intermediate portion. The remaining regions appear mostly small or simple at the present time.

Far-sided imagery suggests further regions are due to rotate onto the disc during the forecast period, especially towards the southeast quadrant. This is also evident in the SDO/AIA 171 imagery, with areas of brightness and magnetic looping seen on, or just beyond the east limb, in both the northern and southern hemisphere.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	40	40	40	40
Very Active	R3-R5 (X Class)	No	5	5	5	5

Figure 5: GOES16 and GOES18 X-Ray Trace over the past 24 hours.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is forecast to persist at background levels, with only a very slight chance of rising above the S1/Minor Radiation Storm threshold.

The majority of the sunspots on the disc are either small or simple with only modest contributions to flare probabilities from most spots, with AR3828 and AR3833 currently in the most favourable position to produce any proton response. There is a non-zero, albeit very low chance of observable protons from any significant filament eruption, given the number and size of notable filaments currently on the disc.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

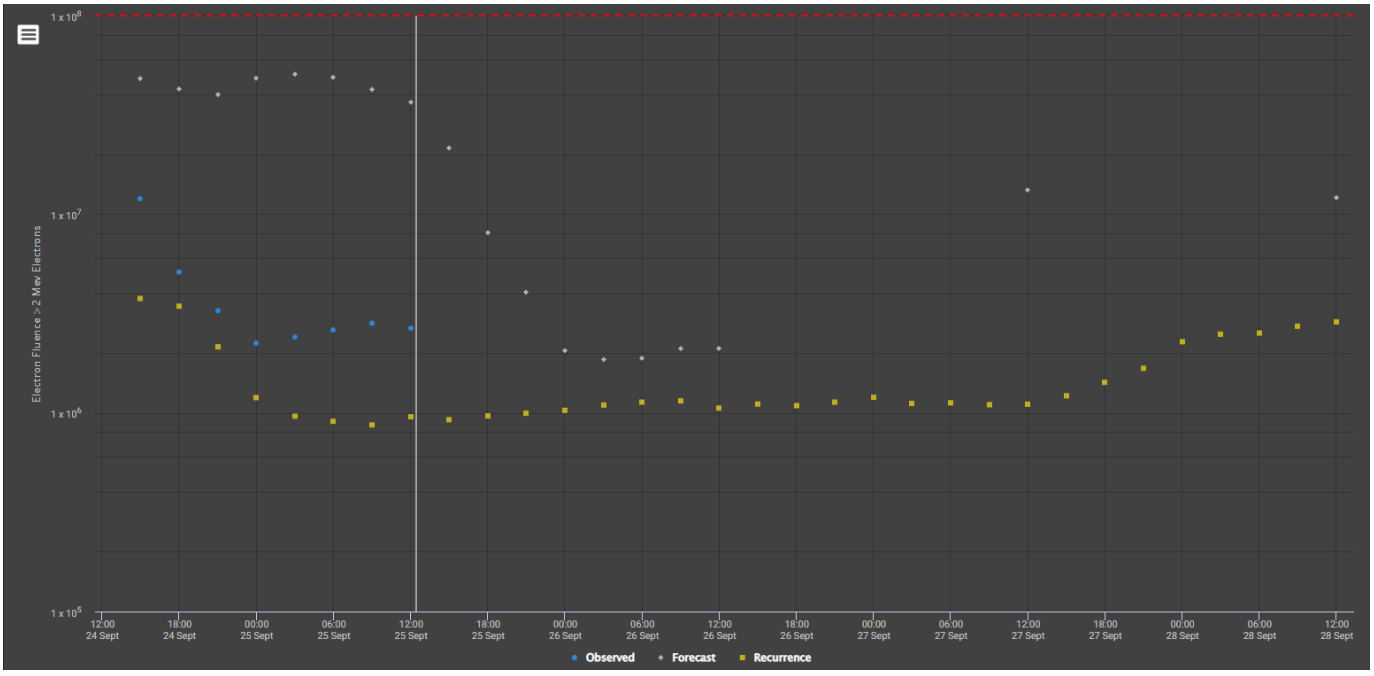
High Energy Electrons (≥ 2MeV)

GOES-16 high energy electron flux is now at background to moderate levels. Due to potential HSS and CME effects, the subsequent increased solar wind pressure is expected to compress the radiation belts once again and suppress observed flux values in the short term. There is potential for the recovery and increase in flux later in the period, after CME and HSS effects have subsided.

The associated 24 hour fluence reached the Active (1e8 integrated pfu) level during 22-23 Sep but has since dropped below the threshold, likely due to the recent weak CME arrival, which arrived midday UTC on 23 Sep. Confidence is low during this period, but it seems most likely that fluence will remain below the Active threshold, before potentially rising late in the period on Day 4 (28 Sep). MOSWOC REFM also suggests a gradual rising trend towards the end of the period, but remains below the threshold.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: MOSWOC REFM showing suggested rise of values later in period.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.